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## DISCUSSIONS

### POLLUTION OF RIVER WATER IN THE PITTSBURGH DISTRICT<sup>1</sup>

The investigation by the United States Engineer Office of pollution of navigable rivers in the Pittsburgh District was most exhaustive. Through the courtesy of the district engineer, the writer has examined this report in some detail and was amazed to find the amount of information which had been collected. While Mr. Young's paper<sup>1</sup> calls attention to the important features, it is unfortunate that the entire report has not been made available for general use and that no action has been taken as a result of the findings.

The investigation establishes that practically all of the streams and rivers of the Pittsburgh district are seriously polluted by acid wastes, the greater portion of which results from coal mining. This is one of the most important industries responsible for the growth of the district as a steel producing centre. While such a serious condition suggests the pressing need for remedial measures, the remedy cannot be too drastic nor can it impose unnecessary burdens or handicaps. On the other hand, the coal mining industry should not be permitted to continue to handicap all of the water using industries of the district, as it now does, without making any attempt to correct conditions. It is unthinkable that all the coal mines should be compelled to discontinue operations pending a solution of the problem, but now that the conditions are more clearly understood and the difficulties of stream pollution are realized, it would seem proper that the policy adopted by some states, of endeavoring to preserve the present purity of streams or at least to control the degree of pollution, should be adopted nationally.

If this subject is sufficiently important for the federal government to investigate, is it not also of sufficient importance to warrant an attempt to find a remedy? It would seem so to the writer, although he has been informed that several agencies of the government have advised that the problem was not of sufficiently wide occurrence to warrant their attention. It is true that at the present time the prob-

<sup>1</sup> JOURNAL, May, 1921, page 201.

lem is acute only in the intensively developed coal mining and industrial districts. As such centers develop elsewhere, however, this problem also will arise. Since damage in one state may result from pollution introduced into the stream in another state, it appears that only the federal government has sufficient power to effect a remedy.

The health department of the State of Pennsylvania has done some work in an effort to develop a method to remove sulphuric acid and its derivatives from water, but has not published any results. It seems probable that the work will be discontinued in an effort to reduce expenses, although the amount so far spent is small in comparison with the losses suffered by the industries affected. It is hoped that this is not correct, as there have been so few serious attempts made to develop a solution of this problem.

As a result of the investigation described by Mr. Young, a bill was introduced in Congress to protect the steel portions of government locks and dams from corrosion by acid waters, by prohibiting the discharge of acid wastes into navigable streams—surely a drastic remedy which would have been difficult to enforce aside from its economic aspects.

The growth of pollution in the rivers has been so gradual that in many cases it has been accepted as a matter of course and the serious injuries to industries are not fully appreciated. In general, the costs due to the use of bad water appear under such a variety of charges that they are usually lost sight of. The actual cost of treatment is usually the smallest part of the increased cost of using a polluted supply. The most serious objection is that, even after treatment the water is much more difficult to use than a naturally, pure water.

The literature of water supply engineering contains comparatively little reference to standards of quality for industrial supplies. One reason for this is the ineffectiveness of existing methods of treatment to produce a satisfactory industrial water from a seriously polluted source. The writer called attention to this matter in discussing several papers at the Montreal Convention last year, and notes that some reference is made to it in the program for the coming convention at Cleveland.

The cost of industrial water supplies when distributed over the output of a given industry is usually but a small part of the total cost. The increasing difficulty in securing satisfactory supplies

and the inability to purify the polluted supplies may be expected to increase the importance of industrial water supply in the future.

The waters of Western Pennsylvania are naturally low in alkalinity, due to the prevailing geological measures. On the other hand, large areas of the district in question, comprising practically all of Southwestern Pennsylvania, are underlain by the coal measures, at several points of which as many as five different seams are being worked. It is undoubtedly true that the natural alkalinity of the streams would be little affected by the discharge from the mills, and that there would be no apparent improvement in the quality of the river water at this time if such discharges should be discontinued. Furthermore, the mills only pollute the streams with acid during the periods of active operation, while the coal mines produce acid waters constantly, continuing even after abandonment. The large area covered by the workable coal measures makes it practically impossible to secure a water supply beyond the outcrop and any supply secured from within the outcrop, even though the coal may still be undeveloped, is exposed to the same hazards unless the pollution may be restrained by legal means.

The disappearance of acid and decomposable salts between Locks No. 2 on the Allegheny and Monongahela and Lock No. 3 on the Ohio does not necessarily improve the water for industrial purposes, as the neutralization has merely altered the form of the sulphate radical, only a minor portion having been removed. Mr. Young states that "it is regrettable that no simple remedy presents itself." This is certainly true, but in the writer's judgment a much stronger statement is fully warranted—that no remedy presents itself. The water treatment plant of the H. C. Frick Coke Company was described by Mr. L. D. Tracey in the May, 1920, issue of *Mining and Metallurgy* and subsequently discussed by the chief chemist of the Frick Company and by the writer. This plant marks an important step in the right direction, in that it pays its way, but the effluent is not suitable for use in boilers or for many other industrial purposes.

The usual methods of water treatment produce a single precipitation, leaving sodium sulphate in solution, and, in general, increase the total solids, although reducing incrusting solids. The presence of small quantities of sodium sulphate is not necessarily harmful, but if the amount is large it introduces many difficulties. As stated by Mr. Young, it seems probable that all forms in which  $\text{SO}_4$  reaches a boiler are harmful. The chemical reactions which occur at high

pressures and temperatures are uncertain, and it seems unnecessary to state that a steam boiler is not a proper place for such experimentation. Barium has been used to a small extent as it has the advantage of removing sulphates and reducing total solids. It has not come into common use for treating boiler water owing to its high cost. For domestic purposes it has the additional disadvantage of the uncertainty as to the conditions under which it is toxic.

Decreasing the total acidity of the rivers by the discharge of waters which have been treated for boiler and cooling purposes is certainly a most extravagant way of producing a desirable result. Possibly the regulating effect of storage reservoirs, as proposed by the Pittsburgh Flood Commission, would produce such an effect at much lower cost.

While it is true that free acid will attack the decomposable or organic matter present in sewage, it is equally true that the sewage could be rendered stable at a lower cost to the public, by the use of sewage treatment plants, rather than as at present by the action of acid mine drainage. The water supply of the City of Altoona (which is not within the district in question) shows free acid and a low bacterial content at all times. Nevertheless it is chlorinated as a further safeguard, and a study is being made in an effort to avoid the use of this polluted water. Practically all of the smaller rivers where coal has been developed are so seriously polluted that no effort is made to use them. At one plant a seriously polluted stream is used in a jet condenser by lining the body with cement, the pump with lead and making other parts of the condenser and pump which come in contact with the water of phosphor bronze. Even under these conditions, certain parts of the condenser must be replaced about every three months. A screen of  $\frac{3}{4}$ -inch copper plate with holes punched through is destroyed in approximately a year's time. Many of the steel mills are equipped to treat the water used to cool the rolls. It is found that the water changes so rapidly that unless it is treated at all times the roll may be seriously damaged.

The life of boiler tubes for locomotive purposes mentioned is in error, as under the then existing Interstate Commerce Commission regulations tubes could not remain in a boiler for more than three years, although during the war this was increased to four. The period of locomotive boiler wash is also prescribed by Interstate Commerce Commission regulations. Using good waters for boiler feed, there is practically nothing in the boiler to be removed at the

end of the prescribed 28-day period. Using polluted or treated waters, the wash must be made much more frequently. One of the larger railroads in the district removes and renews the water in locomotive boilers at the end of each trip. The most serious difficulty due to using bad water is in the possibility of delays on the road. These are also the most difficult to reduce to cost or loss basis, but they are nevertheless just as real as the more direct costs. On occasions it has been impossible to remove coal from mines promptly owing to damage to locomotive boilers caused by using waters polluted with drainage from the mines producing the coal. It is difficult to calculate the total loss due to using bad water, and the total of \$800,000.00 per annum is certainly underestimated.

Reference is made by Mr. Young to the supply of pure water which the Pennsylvania Railroad Company obtains for locomotive use from the mountains to the east. The several water companies which obtain water from that stream have now joined with the Pennsylvania Railroad Company and have entered suits to prevent the destruction of the stream as a water supply by coal mine drainage, as a number of mines have been opened on the watershed within the past few years.

The difference in pollution between the Youghiogheny and Monongahela Rivers may readily be explained by the difference in their drainage areas. The Youghiogheny, being much smaller, naturally shows more serious pollution, as the coal on its watershed has been more extensively developed and the percentage of mine drainage which it carries is greater. The annual report of the City of McKeesport Water Department for 1916-1917 shows that for the period between 1910-1917, the maximum methyl orange acidity of the Youghiogheny River was 390 parts per million, while that of the Monongahela River was 40, and, further, that, while the Youghiogheny is acid in reaction continuously, the Monongahela is usually alkaline. The same report shows that by changing the source of raw water from the Youghiogheny River to the Monongahela River, the cost of chemicals required was reduced 90 per cent. This plant is very successful indeed, but the scale forming content of the effluent water is still so high that large industrial plants find it desirable to treat the same for boiler purposes. This treatment also requires the use of an anti-foam compound.

The City of Pittsburgh procures its water supply from the Allegheny River. The Pennsylvania Department of Health some years

ago made an extensive study of this entire watershed and called attention to the progressive lowering of alkalinity in this river, and the eventual necessity for treating this large supply to remove the industrial pollution as well as for filtering it to improve the sanitary qualities. The annual report of the Bureau of Water of the City of Pittsburgh for 1912 also called attention to that situation. While the city water supply has been acid at the intakes on occasions, this acidity has been of short duration and has been neutralized by the water in the settling basins.

The water situation in the Pittsburgh district is becoming more serious. Stream flows have been unusually favorable during the past few years. The first year of drought during the summer or fall season will undoubtedly produce serious difficulties. The steel hulls of boats and the steel portions of the dams on the rivers in this district are rapidly being attacked by the acid waters. Municipalities are having increased difficulties in furnishing suitable water to their residents. The water required for industrial purposes, as pointed out by Mr. Young, is many times greater in quantity than that required for domestic purposes and the standards are entirely different. With the continued increase in the pollution of streams, pure supplies are becoming more difficult to obtain. Unless methods of industrial purification can be developed, it is difficult to see how additional water supplies for the future growth of this great industrial center will be secured. The problem is of such a serious nature and—the results are so apparent in navigable rivers in various states, that, in the writer's judgment, only the federal government is in a position to cope with the situation. If a careful study of the question should be undertaken at once, with research on a scale comparable with the importance of the problem, it might be possible to have a remedy available by the time the situation becomes acute in other districts, thereby avoiding the problems which today are so serious in the Pittsburgh district.

In conclusion, the writer believes that Mr. Young has contributed a very important paper to the JOURNAL, and recommends that the Association give the subject of industrial water supply serious consideration. If the subject is found to be within the range of its proper activity, the conditions should be brought to the attention of the proper agency of the Federal government for remedial action.

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## ACID POLLUTION OF STREAMS

As a discussion of the paper<sup>1</sup> of Prof. C. M. Young on the acid pollution of the streams of the Pittsburgh Engineer District, I will state that the object of the investigation conducted by the United States Engineers Office was to obtain information bearing on the extent and sources of the acid reaching the rivers and if possible to suggest means to better the conditions complained of by boat men.

Attempts have been made in recent years to have Congress amend the laws for the protection and preservation of the navigable waters of the United States to the end that acid wastes from manufacturing plants, as well as that originating in coal mines, might be controlled, or minimized sufficiently, to reduce materially damage to hulls of steel vessels, steam boilers, valves, lock gates, etc., and incidentally to improve the water for the generation of steam.

It should be understood that the United States exercises no control over waterways save such as are concerned with the *interest of navigation*. With respect to deposits, or refuse, placed in the streams, or on their banks, Section 13, of the River and Harbor Act, approved March 3, 1899, reads, in part, as follows: "That it shall not be lawful to throw, discharge, or deposit, or cause, suffer, or procure to be thrown, discharge, or deposited either from or out of any ship, barge, or other floating craft of any kind or description whatever, other than that flowing from streets and sewers and passing therefrom in a liquid state into any navigable water in the United States, or into any tributary of any navigable water from which the same shall float, or be washed into such navigable water."

Friends of the proposed amendments entertained the hope that ways might be found by the treatment of acid water to obtain by-products of commercial value, useful in the arts, and valuable as fertilizers, obtaining them without increasing the cost, or difficulties of coal mining or seriously inconveniencing manufacturers using acids.

During the course of the investigation more than 260 persons, having more or less knowledge of the subject, were interviewed, included among them being 40 managers of manufacturing industries, 55 mechanical, civil, metallurgical and consulting engineers, 32 chemists, 15 coal operators, 22 Pennsylvania State mine inspectors, 6 city and state officials, 6 physicians expert in bacteriological study, and a number of plumbers, tanners, launderers, railway

officials and round house employees, boiler makers, etc. Especially valuable was the aid given, and facilities furnished for tests, by the United States Bureau of Mines. Data were furnished also by the U. S. Marine Hospital Service which happened, at the same time, to be investigating river conditions along the Ohio at many points for 400 miles below Pittsburgh. The data thus secured along with that obtained by personal examinations of the office assistants, covered 960 pages of typewritten matter. Owing to conditions resulting chiefly from the great war, nothing has been done officially with the data. In fact the work had to be stopped by the press of other duties before any definite recommendations could be made.

It so happens that very low water conditions have not been experienced for several years past, and accordingly there has been more than the usual summer and fall dilution of acids reaching the main streams. It is doubtless the case, however, that the acids from mines is constantly increasing, corresponding with the growth of the coal trade, but at present it is the case that spent acids from steel works, etc., is below the average due to so many plants being either closed, or operated for shorter daily, or weekly, periods.

The Engineer Department of the Army is, of course, interested in the matter of the purification of water supply. It is not only the Pittsburgh region, but coal producing areas in eastern Pennsylvania, Ohio, West Virginia, Indiana, Illinois and Kentucky, which add enormously to the total acid pollution of our rivers. The grand aggregate extends into millions of tons of acid, or acid salts, or bases, annually reaching the streams. Vast as is the annual waste of chemical materials from mines and mills estimated to be worth \$20 per ton, it is not greater than the areas surrounding the mines, in need of the fertilizers said acid might possibly be made to produce. The subject is one that should be studied by the agricultural chemists, as well as by the experts on public water supplies.

THOS. P. ROBERTS.<sup>3</sup>

#### CONTROL OF OPERATION OF FILTER PLANT BY H-ION CONCENTRATION<sup>4</sup>

It is altogether practical to put a set of "color standards" for the determination of hydrogen ion concentration into the hands of an untrained man and get valuable results. This conclusion is

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<sup>4</sup> JOURNAL, May, 1921, page 239.

evident from the experience of the past few months, during which time an untrained man has, with only the briefest explanation of the use of such a set, made daily determination of the *acid index* of a water supply. These tests have been extremely useful in controlling the application of chemicals in a small filter plant where corrosion troubles have been acute for several years.

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